APPENDIX D

EXAMPLE OF UTILITY CAPACITY CALCULATION

D-1 Applicability of this example

This example is intended to illustrate the application of the redundancy and capacity criteria described in chapter 2, Fundamentals of Limited Vulnerability Design, to the selection of utility system capacity for a facility following the LVD concept. It is based solely on the example C4ISR facility, is limited to a single utility, and uses assumptions that are not valid for all facilities, missions, or geographic locations. Therefore, this should be considered an example only and not indicative of the utility requirements of any actual facility. The calculation below applies to the facility configuration described in chapter 3, Architectural and Structural Systems, and presents a methodology for determining the required size of electrical services to meet the specified redundancy criteria. The facility consists of 35,000 GSF. The area is assumed to be divided approximately equally among the four peripheral zones and the command center.

D-2 Calculation of required electrical capacity

The required electrical capacity can be calculated as described below, using assumptions for the design loading of each zone. The capacity is calculated for the following two alternative configurations of the command center electrical system:

a. Configuration 1 in figure D-1 is the simple automatic bus transfer scheme described in chapter 5, Electrical Systems. Each zone source must be capable of supplying 100 percent of the command center load.

b. Configuration 2 as shown in figure D-2, is the command center is supplied by a ring bus with network protectors. With the greater redundancy of this scheme, each zone source must be capable of supplying only 50 percent of the command center load.

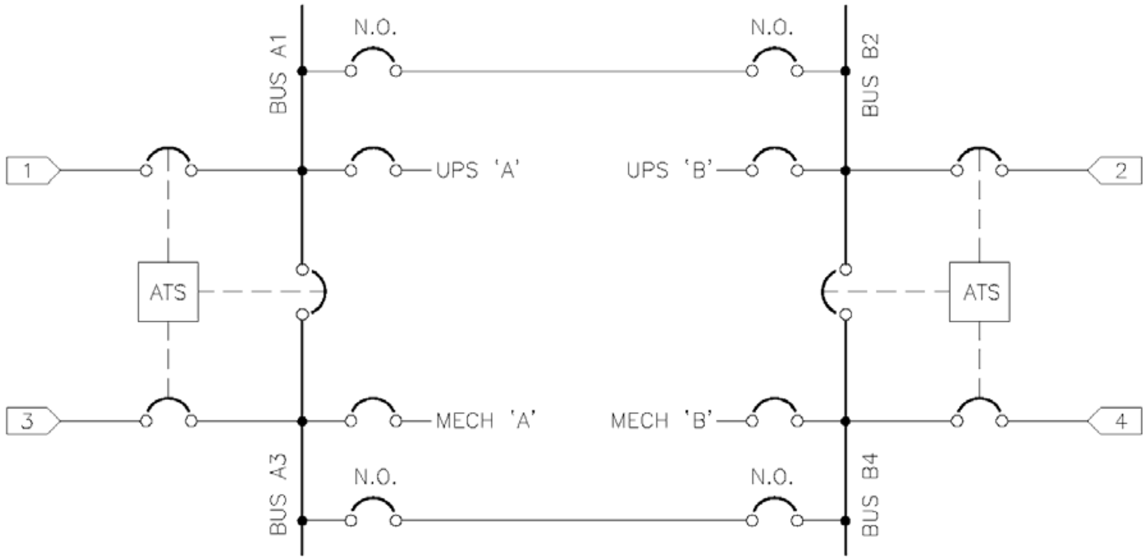

Figure D-1. Single-line diagram – automatic transfer scheme

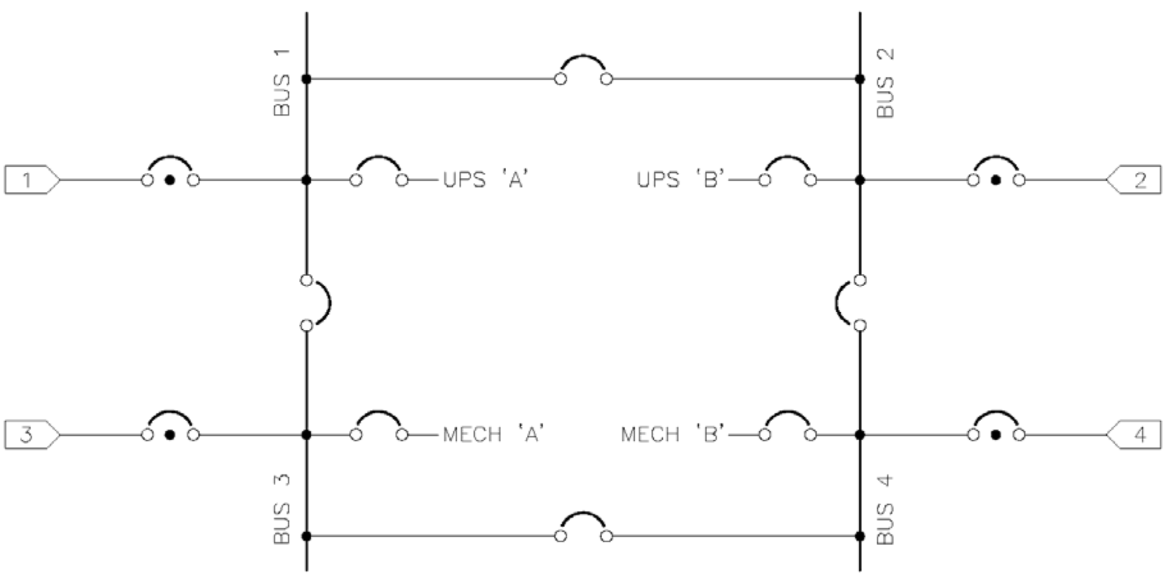

Figure D-2. Single-line diagram – ring bus with network protectors

c. The calculation of the required electrical capacity consists of the following steps:

1. Calculate command center electrical load

Upper level – people and consoles:	7,000 SF @ 25 W/SF = 175 kW
Lower level – servers and communications gear:	7,000 SF @ 50 W/SF = 350 kW
Total command center load:	525 kW

2. Calculate command center cooling load

(525 kW x 3,412 Btu/kWhr)/12,000 Btu-hr/ton = 150 tons cooling

3. Calculate peripheral zone electrical load

Office space – electronic-intensive use:	7,000 SF @ 10 W/SF = 70 kW
Mechanical HVAC (estimated):	50 kW
Total peripheral zone load:	120 kW

4. Calculate cooling capacity for each service

Based on four peripheral zones, each must support itself and 50 percent of the command center load, as follows:

Peripheral zone:	7,000 SF @ 200 SF/ton = 35 tons
50 percent of command center:	150 x 0.5 = 75 tons
Required zone chiller capacity:	110 tons

5. Calculate electrical service capacity

a. Configuration 1

Zone electrical load from step 3:	120 kW
100 percent of command center load from step 1:	525 kW
Zone chilled water system:	110 tons x 1.0 kW/ton = 110 kW
Total required service capacity:	755 kW

b. Configuration 2

Zone electrical load from step 3:	120 kW
50 percent of command center load from step 1:	263 kW
Zone chilled water system:	110 tons x 1.0 kW/ton = 110 kW
Total required service capacity:	493 kW

D-3. Additional considerations

In this example, the more complex command center electrical configuration of figure D-2 reduces the required capacity of each zone service by one-third. The designer would weigh these cost savings at the zone level against the increased cost of the switchgear at the command center level. In selecting a final design, the designer should also consider the potential risk of human error associated with the more complex configuration and the impact of such risk on reliability.